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(54) [Title of the Invention] VOICE ENCODING/DECODING APPARATUS

(57) [Abstract]

[Object] An object is to provide a voice encoding/decoding apparatus capable of encoding/decoding voice with correctness and quality as compared to the conventional, by preparing a plurality of codebooks based on the voice data obtained in various noise environment to determine, in actual voice encoding, a surrounding noise of an input voice to separately use the codebooks.

[Structure] Provided are a noise determining section 100 for analyzing a digital voice signal obtained by an A/D converter 2 to determine a voice environment of an input voice signal, a plurality of encode-end codebooks 11, 12, 13 ... 1n previously memorizing a plurality of sound-source patterns based on the voice data obtained in different noise

environments, a switch circuit 101 for selecting a codebook corresponding to a noise environment determined by the noise determining section 100 to connect it to an encode operating section 3, a plurality of decode end codebooks 21, 22, 23 ... 2n respectively having the same content as the encode-end ones, and a switching circuit 201 for selecting a codebook according to the data contained in a voice code obtained by the encode operating section 3 to connect it to the encode-end operating section 4.

[Claims]

[Claim 1] In a voice encoding apparatus having

an A/D converting section for converting an input voice signal from an analog voice signal into a digital voice signal,

a registering section previously recoded with a plurality of sound-source patterns, and

an encode operating section for voice-encoding a digital voice signal obtained by the A/D converting section by using a sound-source pattern registered in the registering section, the voice encoding apparatus characterized in that:

the registering section is previously registered with a plurality of sound-source pattern groups respectively obtained in different noise environments on the basis of a group of voice data;

further comprising a noise determining section for analyzing a digital voice signal obtained by the A/D converting section and determining a noise environment of the input voice signal; and

switch means for selecting and connecting a sound-source pattern group corresponding to a noise environment determined by the noise determining section and connecting it to the encode operating section;

whereby the encode operating section is configured to voice-encode the input voice signal by using the sound-source pattern connected by the switch means.

[Claim 2] In a voice decoding apparatus having

a registering section previously registered with a plurality of sound-source patterns, and

a decode operating section for selecting sound-source pattern data registered in the registering section according to a given voice code to generate the selected sound-source pattern data as a digital voice signal, and a D/A converter for converting the digital voice signal generated by the decode operating section into an analog voice signal, the voice decoding apparatus characterized by comprising:

switch means for selecting a sound-source pattern group from the registering section according to data contained in the voice code to connect it to the decode operating section;

the decode operating section being configured to generate a digital voice signal from a voice code by using the sound-source pattern group connected by the switch means.

[Claim 3] In a voice encoding apparatus having

an A/D converting section for converting an input voice signal from an analog voice signal into a digital voice signal,

a registering section previously stored with a plurality of sound-source patterns, and

an encode operating section for sound-encoding the digital voice signal obtained by the A/D converting section by using the sound-source pattern registered in the registering section, the voice encoding apparatus characterized in that:

the registering section is previously registered with a plurality of environment noise sound-source patterns based on environment noise data obtained in different noise environments and a plurality of basic sound-source patterns based on voice data obtained in comparatively low noise environments;

further comprising a noise determining section for analyzing the digital voice signal obtained by the A/D converting section and determining a noise environment of the input voice signal;

switch means for selecting an environment noise sound-source pattern corresponding to a noise environment of

the input voice signal determined by the noise determining section from the registering section; and

compositing means for compositing a signal of the environment noise sound-source pattern selected by the switch means with a signal of each basic sound-source pattern;

whereby the encode operating section is configured to sound-encode the input voice signal by using an output of the compositing means.

[Claim 4] A voice encoding apparatus according to claims 1 and 3, wherein the noise determining section is configured to obtain a plurality of noise environments as a determination result.

[Claim 5] In a voice encoding/decoding apparatus having

an A/D converting section for converting an input voice signal from an analog voice signal into a digital voice signal,

an encode-end registering section previously registered with a plurality of sound-source patterns,

an encode operating section for sound-encoding a digital voice signal obtained by the A/D converting section by using the sound-source pattern registered in the encode-end registering section,

a decode-end registering section registered with a same content as a registration content of the encode-end registering section,

a decode operating section for selecting data of a sound-source pattern registered in the encode-end registering section according to a voice code obtained by the encode operating section and generating the data of the selected sound-source pattern as a digital voice signal, and

a D/A converting section for converting the digital voice signal generated by the decode operating section into an analog voice signal, the voice encoding/decoding apparatus characterized in that:

the encode-end registering section and the decode-end registering section are previously registered with a plurality of sound-source pattern groups respectively obtained based on a group of voice data in different noise environments;

further comprising a noise determining section for analyzing the digital voice signal obtained by the A/D converting section and determining a noise environment of the input voice signal;

encode-end switch means for selecting and connecting a sound-source pattern group corresponding to a noise environment determined by the noise determining section from the encode-end registering section and connect it to the encode operating section; and

decode-end switch means for selecting a sound-source pattern group from the decode-end registering section according to data included in a voice code obtained by the

encode operating section and connecting it to the decode operating section;

whereby the encode operating section sound-encodes the input voice signal by using the sound-source pattern connected by the encode-end switch means;

the decode operating section being configured to generate a digital voice signal from a voice code by using the sound-source pattern group connected by the decode-end switch means.

[Claim 6] In a voice encoding/decoding apparatus having

an A/D converting section for converting an input voice signal from an analog voice signal into a digital voice signal,

an encode-end registering section previously registered with a plurality of sound-source patterns,

an encode operating section for sound-encoding a digital voice signal obtained by the A/D converting section by using the sound-source pattern registered in the encode-end registering section,

a decode-end registering section registered with a same content as a registration content of the encode-end registering section,

a decode operating section for selecting data of a sound-source pattern registered in the decode-end registering section according to a voice code obtained by the encode

operating section and generating the data of the selected sound-source pattern as a digital voice signal, and

a D/A converting section for converting the digital voice signal generated by the decode operating section into an analog voice signal, the voice encoding/decoding apparatus characterized in that:

the encode-end registering section is previously registered with a plurality of environment noise sound-source patterns based on environment noise data obtained in different noise environments and a plurality of basic sound-source patterns based on voice data obtained in comparatively low noise environments;

the decode-end registering section being registered with a same content as a registration content of the basic sound-source pattern of the encode-end registering section;

further comprising a noise determining section for analyzing a digital voice signal obtained by the A/D converting section and determining a noise environment of the input voice signal;

switch means for selecting an environment noise sound-source pattern corresponding to the noise environment of the input signal determined by the noise determining section from the encode-end registering section; and

compositing means for compositing a signal of an environment noise sound-source pattern selected by the switch means with a signal of each basic sound-source pattern;

whereby the encode operating section sound-encodes the input voice signal by using an output of the compositing means;

the decode operating section being configured to generate a digital voice signal from a voice code by using only the basic sound-source pattern registered in the decode-end registering section.

[Claim 7] A voice encoding/decoding apparatus according to claims 5 and 6, wherein the noise determining section is configured to obtain a plurality of noise environment as a determination result.

[Detailed Description of the Invention]

[0001]

[Field of the Invention]

The present invention relates to a voice encoding/decoding apparatus, i.e. an apparatus for capturing and encoding a voice to decode and output it again as a sound.

[0002]

The technique that the analog voice waveform signal obtained by capturing a human utterance speech through a microphone is converted to and transmitted or recorded by a code represented by a digital signal is termed as voice encoding. On the other hand, the conversion of a code obtained by voice

encoding into an analog waveform is termed as decoding. The analog voice waveform signal obtained by this, if outputted through a speaker, is reproduced as a speech audible for the human.

[0003]

The foregoing technique for encoding/decoding of voice signals is today utilized broadly. These include, as one, a voice encoding scheme termed a CELP (Code Excited Liner Prediction) scheme expected for so-called digital telephone applications because of low bit rate, i.e. capable of transmitting signals at less bits.

[0004]

Fig. 8 is a block diagram showing a conventional apparatus configuration for realizing a CELP voice encoding scheme, i.e. one configuration example of a conventional CELP voice encoding apparatus. In Fig. 8, reference numeral 1 shows a microphone to capture a voice and output it as an analog voice waveform signal.

[0005]

Reference numeral 2 is an A/D converter for sampling, at an appropriate sampling frequency, and quantize the analog signal outputted from the microphone 1.

[0006]

Reference numeral 3 is an encode operating section. Although the detail is omitted, the correlation data due to

linear prediction/pitch prediction and its residual waveform are determined from the quantized data obtained by the A/D converter 2. Although an input voice is to be encoded by these of data, it is impossible to realize low bit rate with the foregoing residual waveform as it is. As hereinafter referred, utilized is the data for specifying selected one from a plurality of patterns previously prepared. The actual process for selection adopts a technique approximate to the pattern matching that the data is again combined in the encode operating section 3 so that a result thereof is compared with the quantized data obtained previously by the A/D converter 2 thereby selecting an optimal sound-source pattern.

[0007]

Reference numeral 10 is an encoding-end registering section to previously store, as one codebook, a plurality of sound-source patterns required in selecting a sound-source pattern by the encode operating section 3 as described above. Incidentally, the sound-source patterns of the encode-end codebook previously registered in the encode-end registering section 10 are generally based upon the voice data collected in an ideal environment extremely low in surrounding noise.

[0008]

Reference numeral 4 is a decode operating section to convert a voice code outputted from the encode operating section 3 into a digital voice signal. For this purpose,

because there is a need for a codebook having the same content as the encode-end codebook registered in the encode-end registering section 10, a decode-end registering section 20 is provided registering a decode-end codebook having the same content as the encode-end codebook.

[0009]

Reference numeral 5 is an A/D converter to convert the digital voice signal obtained by the decode operating section 4 into an analog voice waveform signal. The analog voice waveform signal is outputted from the speaker 6 and reproduced as a voice audible for the human.

[0010]

Incidentally, in the conventional example shown in Fig. 8, the voice code outputted from the encode operating section 3 is immediately provided to and reproduced by the encode operating section 4. However, actually, where for example the foregoing apparatus is built in a telephone, during usual communication the part on the side of the encode operating section 3 and the part on the side of the decode operating section 4 are on different telephones, wherein a telephone network is interposed between the both. Meanwhile, in the case that certain storing means, e.g. a memory IC or flexible disk, is interposed between the encode operating section 3 and the decode operating section 4 within one telephone, it is possible to provide a function as so-called absent recording.

[0011]

[Problem to be Solved by the Invention]

In the meanwhile, the conventional CELP voice encoding scheme is realized by the apparatus as in the foregoing. Accordingly, in the case there is difference in noise environment at site where voice is inputted to the microphone, there occurs a possibility that the process on the encoding end be not correctly made in selecting a sound-source pattern from the codebook based on the voice data collected in an ideal environment where surrounding noise is inherently low.

[0012]

The present invention has been made in view of such circumstances. It is an object of the first invention to provide a voice encoding/decoding apparatus previously registered with a plurality of codebooks based on the voice data obtained in various noise environments, to determine a surrounding noise of an input voice upon actual voice encoding and separately use the codebooks thereby enabling correct, high-quality voice encoding/decoding as compared with the conventional.

[0013]

Meanwhile, it is an object of the second invention to provide a voice encoding/decoding apparatus prepared with a codebook storing a plurality of sound-source patterns having, as data, the noises per se in various noise environments, to

determine a surrounding noise of an input voice upon actual voice encoding and encode the input voice by using a result of combination of a sound-source pattern corresponding to that and the basic sound-source pattern thereby enabling correct, high-quality voice encoding/decoding as compared with the conventional.

[0014]

[Means for Solving the Problem]

A voice encoding/decoding apparatus according to the present invention having an A/D converting section for converting an input voice signal from an analog voice signal into a digital voice signal, an encode-end registering section previously registered with a plurality of sound-source patterns, an encode operating section for sound-encoding a digital voice signal obtained by the A/D converting section by using the sound-source pattern registered in the encode-end registering section, a decode-end registering section registered with a same content as a registration content of the encode-end registering section, a decode operating section for selecting data of a sound-source pattern registered in the encode-end registering section according to a voice code obtained by the encode operating section and generating the data of the selected sound-source pattern as a digital voice signal, and a D/A converting section for converting the digital voice signal generated by the decode operating section into

an analog voice signal, is characterized in that: the encode-end registering section and the decode-end registering section are previously registered with a plurality of sound-source pattern groups respectively obtained based on a group of voice data in different noise environments; further comprising a noise determining section for analyzing the digital voice signal obtained by the A/D converting section and determining a noise environment of the input voice signal; encode-end switch means for selecting a sound-source pattern group corresponding to a noise environment determined by the noise determining section from the encode-end registering section and connecting it to the encode operating section; and decode-end switch means for selecting a sound-source pattern group from the decode-end registering section according to data included in a voice code obtained by the encode operating section and connecting it to the decode operating section.

[0015]

Also, a voice encoding/decoding apparatus according to the invention having an A/D converting section for converting an input voice signal from an analog voice signal into a digital voice signal, an encode-end registering section previously registered with a plurality of sound-source patterns, an encode operating section for sound-encoding a digital voice signal obtained by the A/D converting section by using the sound-source pattern registered in the encode-end registering

section, a decode-end registering section registered with a same content as a registration content of the encode-end registering section, a decode operating section for selecting data of a sound-source pattern registered in the decode-end registering section according to a voice code obtained by the encode operating section and generating the data of the selected sound-source pattern as a digital voice signal, and a D/A converting section for converting the digital voice signal generated by the decode operating section into an analog voice signal, the voice encoding/decoding apparatus is characterized in that: the encode-end registering section is previously registered with a plurality of environment noise sound-source patterns based on environment noise data obtained in different noise environments and a plurality of basic sound-source patterns based on voice data obtained in comparatively low noise environments; the decode-end registering section being registered with a same content as a registration content of the basic sound-source pattern of the encode-end registering section; further comprising a noise determining section for analyzing a digital voice signal obtained by the A/D converting section and determining a noise environment of the input voice signal; switch means for selecting an environment noise sound-source pattern corresponding to the noise environment of the input signal determined by the noise determining section from the encode-end

registering section; and combining means for combining a signal of an environment noise sound-source pattern selected by the switch means with a signal of each basic sound-source pattern.

[0016]

[Operation]

In the voice encoding/decoding apparatus of the invention, using a sound-source pattern group (codebook) connected by encode-end switch means, an encode operating section sound-encodes an input voice signal while, using a sound-source pattern group (codebook) connected by decode-end switch means, a decode operating section generates a digital voice signal from a voice code.

[0017]

Meanwhile, in the voice encoding/decoding apparatus of the invention, the encode operating section sound-encodes the input voice signal by using an output of the compositing means and the decode operating section generates a digital voice signal from a voice code by using only a decode-end basic sound-source pattern group (codebook).

[0018]

[Embodiment]

Hereunder, the present invention will be described in detail on the basis of the drawings showing the embodiment thereof. Fig. 1 is a block diagram showing a voice encoding/decoding apparatus of the invention, i.e. one

configuration example of a first embodiment of a CELP encoding apparatus.

[0019]

In Fig. 1, reference numeral 1 shows a microphone to capture a voice and output it as an analog voice waveform.

[0020]

Reference numeral 2 is an A/D converter to sample, at an appropriate sampling frequency, an analog voice waveform signal outputted from the microphone 1 and quantize it. The quantized data obtained by the A/D converter 2 is provided to an encode operating section 3 and noise determining section 100.

[0021]

The encode operating section 3, although the detail is omitted, determines correlation data due to linear prediction/pitch prediction from the quantized data obtained from the A/D converter 2, to determine a residual waveform thereof. Although the input voice is encoded by these data, the present embodiment previously prepares them respectively in the encode-end codebooks 11, 12, 13 ... 1n in n kinds as hereinafter explained. Incidentally, these encode-end codebooks 11, 12, 13 ... 1n are previously registered in a encode-end registering section 10.

[0022]

The encode-end codebooks 11, 12, 13 ... 1n are different in noise environments, e.g. the encode-end codebook (1) 11 is a basic codebook based on the voice data collected in an ideal environment extremely low in surrounding noise similarly to the encode-end codebook in the conventional example, the encode-end codebook (2) 12 is a codebook based on the voice data collected in a crowd, the encode-end codebook (3) 13 is a codebook based on the voice data collected in an automobile, ..., the encode-end codebook (n) 1n is a codebook based on the voice data collected in a station precincts.

[0023]

The noise determining section 100 is given with the quantized data outputted from the A/D converter 2, as noted before. By spectrum-analyzing it, a feature is extracted to determine a distinction of noise environment of the sound, e.g. environment almost free of noise, in a crowded, in an automobile, ... in a station precincts. The determination result by the noise determining section 100 is outputted as a signal specifying an input-sound noise environment (noise determination code) to the encode operating section 3 and switching circuit 101.

[0024]

The switching circuit 101 selectively connects, to the encode operating section 3, a corresponding one of a plurality of encode-end codebooks 11, 12, 13, ... 1n previously

registered in the encode-end registering section 101 according to a noise determination code given from the above noise determining section 100.

[0025]

Accordingly, the encode operating section 3 combines an output signal by using any one of the encode-end codebooks (1) (or (2)12, (3)13 ... (n)1n) connected by the switching circuit 101, to select such a sound-source pattern that the combined voice is closest to the input sound. The data specifying the sound-source pattern thus selected (e.g. codebook No. and pattern No.) is outputted, together with the previously obtained correlation data due to linear prediction/pitch prediction and noise determination code, as a voice code to the decode operating section 4.

[0026]

Reference numeral 4 is a decode operating section to convert the voice code outputted from the encode operating section 3 into a digital voice signal. For this purpose, because there is a need for the codebooks having the same content as the encode-end codebooks 11, 12, 13 ... 1n, the decode operating section 4 is also provided with a decode-end registering section 20 previously registered with a plurality of decode-end codebooks 21, 22, 23 ... 2n. Namely, the decode-end codebook (1) 21 is a basic codebook based on the voice data collected in an ideal environment extremely low

in surrounding noise similar to the decode-end codebook in the conventional example, to have the same content as the encode-end codebook (1) 11. The decode-end codebook (2) 22 is a codebook based on the voice data collected in a crowd, to have the same content as the encode-end codebook (2) 12. The decode-end codebook (3) 23 is a codebook based on the voice data collected in an automobile, to have the same content as the encode-end codebook (3) 13. The decode-end codebook (n) 2n is a codebook based on the voice data collected in a station precincts, to have the same content as the encode-end codebook (n) 1n.

[0027]

Reference numeral 201 is a switching circuit to connect, to the decode operating section 4, any one of the decode-end codebooks 21, 22, 23 ... 2n registered in the above encode registering section. Specifically, as mentioned before, from the encode operating section 3 to the decode operating section 4 is given also a noise determination code determined by the noise determining section 100. Accordingly, by providing the noise determination code to the switching circuit 201 by the decode operating section 4, the switching circuit 201 selectively connects one decode-end codebook (1) 21 (or (2) 22, (3) 23 ... (n) 2n) to the decode operating section 4.

[0028]

Reference numeral 5 is an A/D converter to convert the digital voice signal obtained by the decode operating section 4 into an analog voice waveform signal. The analog voice waveform signal is outputted from the speaker 6 and reproduced as a voice audible for the human.

[0029]

Incidentally, in the embodiment of the invention shown in Fig. 1, the voice code outputted from the encode operating section 3 is immediately provided to the decode operating section 4, thus being reproduced. However, actually, in the case that for example the apparatus of the invention is built in a telephone, during usual communication the part on the side of the encode operating section 3 and the part on the side of the decode operating section 4 are on different telephones, wherein a telephone network is interposed between the both. Meanwhile, in the case that certain storing means, e.g. a memory IC or flexible disk, is interposed between the encode operating section 3 and the decode operating section 4 within one telephone, it is possible to provide a function as so-called absent recording.

[0030]

Next, the operation of the above apparatus of the invention will be explained with reference to the flowchart of Fig. 2 showing the procedure of an encoding process. Explanation is made with reference to the flowchart of Fig.

3 showing the procedure of a noise determining process by the noise determining section 100 and the flowchart of Fig. 4 showing the procedure of a decoding process. Incidentally, in the explanation below, the voice input to the microphone 1 has been assumably made in the crowd as one example.

[0031]

When a voice is inputted from the external to the microphone (step S11), it is converted into an analog voice waveform and provided to the A/D converter 2 (step S12). The A/D converter 2 quantizes the input analog voice waveform at a predetermined sampling frequency and provides obtained quantized data to the encode operating section 3 and noise determining section 100.

[0032]

Herein, noise determination is first made by the noise determining section 100 (step S13). The concrete process procedure is shown in the flowchart of Fig. 3. Incidentally, the noise determining section 100 is previously registered with the spectral features of the noises in the noise environment corresponding to the codebook 11 (21), 12 (22), 13 (23)... 1n(2n).

[0033]

First, the noise determining section 100 extracts the frame data in an amount of a certain period, e.g. 5 seconds, from the input voice (step S131), calculates a spectrum thereof

(step S132) and extracts a feature of the spectrum on the basis of the result (step S133). The noise determining section 100 determines which one of the pre-registered noise environments are closest, in each noise environment previously registered, to the spectral feature extracted before (step S134). A noise determination code is outputted according to a result of determination by the noise determining section 100 (step S135), which is provided to the switching circuit 101 and encode operating section 3. Incidentally, it is herein assumed that, because the voice input to the microphone 1 has been made in the crowd, the noise determining section 100 outputs a noise determination code representative of a noise environment of in the crowd to the switching circuit 101 and encode operating section 3.

[0034]

By the above, the encode operating section 3 selects as it is the noise determination code outputted from the noise determining section 100 (step 14), and the switching circuit 101 operates such that the encode-end codebook (2) 12 is connected with the encode operating section 3. Consequently, the encode operating section 3 uses each sound-source pattern of the encode-end codebook (2) 12 for in the crowd, to perform an encode process on the input voice (step S15).

[0035]

After determining which one of the sound-source patterns is optimal, the encode operating section 3 outputs the data specifying a selected sound-source pattern (e.g. codebook No. and pattern No.), together with the before-obtained correlation data due to linear prediction/pitch prediction and noise determination code, to the encode operating section 4.

[0036]

The encode operating section 4 outputs the noise determination code of among the data outputted from the encode operating section 3 to the switching circuit 201. Due to this, the switching circuit 201 operates to connect the codebook (2) 22 of in the crowd of among the encode-end codebooks 21, 22, 23 .. 2n previously registered in the decode-end registering section 20 to the decode operating section 4 (step S21). Accordingly, the decode operating section 4 selects a designated sound-source pattern from among the sound-source patterns in the codebook (2) 22 and combines it with other data thereby effecting decoding (step S22). As a result, a digital voice waveform is outputted from the decode operating section 4.

[0037]

The digital voice waveform outputted from the decode operating section 4 is converted by the D/A converter 5 into an analog voice waveform (step S23). This is outputted from

the speaker 6 and reproduced as a voice audible for the human (step S24).

[0038]

Next, a second embodiment according to the configuration of Fig. 1 will be explained. The second embodiment is configured such that a plurality of noise environments are once selected in the noise determining process of step S13 and finally narrowed into one.

[0039]

Fig. 5 is a flowchart showing the procedure of a noise determining process by the noise determining section 100 of the second embodiment. In Fig. 5, steps S141, S142 and S143 are respectively the same processes as the steps S131, S132 and S133.

[0040]

When a spectrum feature is extracted in step S143, the noise determining section 100 determines a plurality (m in the number) of noise environment codes in the closer order and outputs them to the encode operating section 3.

[0041]

Fig. 6 is a flowchart showing a procedure of selecting noise determination codes by the encode operating section 3.

[0042]

Because noise determination codes in the number of m are outputted by the above process of the noise determining section

100, the encode operating section 3 first substitutes m for parameter i (step S151) and selects an optimal sound-source pattern out of the codebook corresponding to a noise determination code in the order of i in the encode-end codebook 11, 12, 13 ... 1n (step S152). Next, the encode operating section 3 takes Xi as an approximation degree of the sound-source pattern to the input voice and compares it with the past maximum approximation degree Xmax (step S153). In the case of Xi > Xmax, Xi is newly rendered Xmax (step S155). In the other case, it is maintained as it is and the parameter i is incremented by "1" (step S156). If the above process of steps S152 to S156 is repeated until the parameter i reaches "1" (step S157), the same process is made on all the noise determination codes in the number of m determined before.

[0043]

As a result, because an optimal source pattern is found correspondingly to Xmax from any in the codebook corresponding to the noise determination codes in the number of m determined before, the encode operating section 3 selects a noise determination code in the order the Xmax has been determined (step S158).

[0044]

In the below, by carrying out the process of step S15 of Fig. 2, encoding is made by the encode operating section 3 with using the codebook corresponding to the selected noise

determination code. Of course, the decoding process by the decode operating section 4 is quite similar to the flowchart shown in Fig. 4.

[0045]

Next, a third embodiment will be explained. Fig. 7 is a block diagram showing one configuration example for realizing a third embodiment of a voice encoding/decoding apparatus of the invention. Incidentally, in Fig. 7, the same reference numerals as those of Fig. 1 referred in explaining the first embodiment represent the same or corresponding parts.

[0046]

In the third embodiment, a basic codebook 30 and an environment noise codebook 31 having voice data of only various environmental noises are previously registered, as an encode-end codebook, in the encode-end registering section 10. In the environment noise codebook 31, prepared are a sound-source pattern having noise in a crowd as voice data, a sound-source pattern having noise in an automobile as voice data, a sound-source pattern having noise in a station precincts as voice data, and the like.

[0047]

Meanwhile, differently from the first embodiment shown in the foregoing Fig. 1, the third embodiment is not provided with a switching circuit 101 so that the configuration is provided to deliver an output of the environment noise codebook

31 to the encode operating section 3 through a combining circuit 32. The combining circuit 32 is given with an output of the basic codebook 30. Namely, the configuration is made to combine, by the combining circuit 32, a data output of any voice pattern in the basic codebook 30 and an output of any environment noise sound-source pattern selected by a noise determination code outputted from the noise determining section 100, and delivered to the encode operating section 3.

[0048]

On the other hand, the decode-end registering section 20 of the decode operating section 4 is registered with only the basic codebook having the same content as the basic codebook 30.

[0049]

The operation of the third embodiment of the voice encoding/decoding apparatus of the invention thus configured is as in the following.

[0050]

It is similar to the foregoing first embodiment that noise determination is made by the noise determining section 100 to output one noise determination code. It is herein assumed, as one example, that voice input to the microphone has been made in a crowd.

[0051]

In this case, because the noise determining section 100 outputs a noise determination code representing that the noise environment of input voice is in the crowd, a voice pattern for crowd in the environment noise codebook 31 is selected and outputted to the combining circuit 32. On the other hand, the encode operating section 3 outputs, in order, the sound-source patterns in the basic codebook 30 to the combining circuit 32, to compare the signal combined with the sound-source pattern for crowd outputted from the environment noise codebook 31 with the signal given from the A/D converter 2, thereby selecting an optimal sound-source pattern. The data specifying the sound-source pattern of a resultingly selected basic codebook 30 (e.g. sound-source pattern No.) is outputted, together with the correlation data obtained before due to linear prediction/pitch prediction, to the decode operating section 4, similarly to the foregoing first embodiment. Incidentally, in the third embodiment, there is no case that a noise determination code is sent from the encode operating section 3 to the decode operating section 4.

[0052]

The decode operating section 4 first selects a sound-source pattern from the basic codebook 40 according to the data outputted from the encode operating section 3 as in the above, and combines it with another one of data to generate a digital voice waveform. The digital voice waveform

generated by the decode operating section 4 is delivered to the D/A converter 5 and converted into an analog voice waveform, further being outputted from the speaker 6 and reproduced as a voice audible for the human.

[0053]

Incidentally, it is needless to say that configuration may be made such that, similarly to the foregoing second embodiment, in also the third embodiment, the noise determining section 100 determines a plurality of determination results to select an optimal sound-source pattern from among the combination results, by the combining circuit 32, of each of a plurality of environment noise sound-source patterns in a environment noise codebook 31 corresponding to them and each sound-source pattern in the basic codebook 30.

[0054]

[Effect of the Invention]

As described in detail above, according to the encoding/decoding apparatus of the present invention, prepared are a plurality of sound-source pattern groups (codebooks) based on the voice data obtained in various noise environments. During actual voice encoding, a surrounding noise of an input voice is determined to separately use the sound-source pattern groups (codebooks) thereby enabling correct, high-quality voice encode/decode as compared with the conventional.

[0055]

Meanwhile, according to the voice encoding/decoding apparatus of the invention, prepared are a plurality of sound-source pattern groups (codebooks) memorizing a plurality of sound-source patterns having, as data, the noises per se in various noise environments. During actual voice encoding, a surrounding noise of an input voice is determined. By using a result of compositing the corresponding sound-source pattern and a basic sound-source pattern, the input voice is encoded thereby enabling correct, high-quality voice encode/decode as compared with the conventional.

[Brief Description of the Drawings]

[Fig. 1] A block diagram showing one configuration example of a first embodiment of a voice encoding/decoding apparatus of the present invention.

[Fig. 2] A flowchart showing the procedure of an encoding process in the first embodiment of the voice encoding/decoding apparatus of the invention.

[Fig. 3] A flowchart showing the procedure of a noise determining process in the first embodiment of the voice encoding/decoding apparatus of the invention.

[Fig. 4] A flowchart showing the procedure of a decoding process in the first embodiment of the voice encoding/decoding apparatus of the invention.

[Fig. 5] A flowchart showing the procedure of a noise determining process in a second embodiment of a voice encoding/decoding apparatus of the invention.

[Fig. 6] A flowchart showing the procedure of an encoding process in the second embodiment of the voice encoding/decoding apparatus of the invention.

[Fig. 7] A block diagram showing one configuration example of a third embodiment of a voice encoding/decoding apparatus of the invention.

[Fig. 8] A block diagram showing one configuration example of a conventional voice encoding/decoding apparatus.

[Explanation of Reference Numerals and Signs]

2 A/D converter

3 Encode operating section

4 Decode operating section

5 D/A converter

10 Encode-end registering section

11, 12, 13 ... 1n Encode-end codebooks

20 Decode-end registering section

21, 22, 23 .. 2n Decode-end codebooks

30 Basic codebook

31 Environment noise codebook

32 Compositing circuit

40 Basic codebook

100 Noise determining section

101 Switching circuit

102 Switching circuit

[Fig. 1]

3 Encode operating section

4 Decode operating section

100 Noise determining section

11 Codebook (1) (Basic)

12 Codebook (2) (in crowd)

13 Codebook (2) (in automobile)

1n Codebook (2) (in station precincts)

21 Codebook (1) (Basic)

22 Codebook (2) (in crowd)

23 Codebook (2) (in automobile)

2n Codebook (2) (in station precincts)

[Fig. 2]

Encoding process

Start

S11 Mike input

S12 A/D conversion

S13 Noise determination

S14 Noise determination signal selection

S15 Encode by using a codebook corresponding to a selected noise determining code.

End

[Fig. 3]

Noise determination

S131 Extract frame in constant period of input sound

S132 Calculate spectrum

S133 Extract spectrum feature

S134 Determine noise environment the spectrum feature is closest

S135 Output determined noise determining code

Return

[Fig. 4]

Start

S21 Select codebook

S22 Decode by using selected codebook

S23 D/A conversion

S24 Speaker output

End

[Fig. 5]

Noise determination

S141 Exract frame in constant period of input sound

S142 Calculate of spectrum

S143 Extract spectrum feature

S144 Determine noise environments in kinds m in the order of closer spectrum feature.

S145 Output noise determining codes in the number of m

[Fig. 6]

Noise determining code selection

S152 Select optimal sound-source pattern from codebook corresponding to noise determining code in the first order.

S153 Compare between approximate degree Xi of selected sound-source pattern and approximate degree Xmax of the past maximum.

S158 Select noise determining code in the order that Xmax has been determined.

Return

[Fig. 7]

3 Encode operating section

4 Decode operating section

100 Noise determining section

31 Environment Noise codebook

32 Compositing circuit

[Fig. 8]

3 Encode operating section

4 Decode operating section